Int Surg 2019;**104:**556–562
DOI: 10.9738/INTSURG-D-15-00182.1

Effect of Peritoneal Incision on Immediate Pain After Inguinal Hernia Repair: A Prospective Cohort Study

Yusuf Tanrikulu[1], Mithat Cagsar[1], Boran Yalcin[1], Furuzan Kokturk[2], Gokhan Yilmaz[1], Volkan Temi[1]

[1]*Department of General Surgery, Zonguldak Ataturk State Hospital, Zonguldak, Turkey*

[2]*Bülent Ecevit University Faculty of Medicine, Department of Biostatistics, Zonguldak, Turkey*

Hernia repair is a common surgical procedure, and postoperative pain is an inevitable result of hernia surgery. The prevention of postoperative pain is of considerable importance in terms of patient comfort and early discharge. In this study, we evaluated the effects of a peritoneal incision on pain in the early postoperative period. This was a prospective clinical study with 75 patients undergoing inguinal hernia repair. Patients were divided into 5 groups: indirect hernia, group 1; Lichtenstein repair with peritoneal incision, group 2: indirect hernia, Lichtenstein repair without peritoneal incision, group 3; all hernias, transabdominal preperitoneal repair, group 4; all hernias, total extraperitoneal repair, and direct hernia, Lichtenstein repair with no peritoneal incision, group 5. Groups were compared in terms of postoperative pain scores at 3 different times and complications. There were 62 males and 13 females; their average age was 51.25 years. The visual analog scale (VAS) scores were lower in groups 2, 4, and 5, and there were differences among groups and within each group according to VAS changes assessed at all time points ($P < 0.05$). There was no difference, according to VAS analysis, between open and laparoscopic surgery groups. There was a difference according to VAS changes in each group between hernia sides ($P < 0.001$). Peritoneal incision is a significant risk factor for postoperative pain after inguinal hernia repair. However, surgical procedure was not a risk factor although VAS scores were higher in open versus laparoscopic surgery.

Key words: Inguinal hernia – Inguinodynia – Mesh hernia repair – Postoperative pain

Corresponding author: Yusuf Tanrikulu, Zonguldak Atatürk Devlet Hastanesi Genel Cerrahi Kliniği, 67100, Zonguldak, Turkey. Tel.: +90 505 657 9709; Fax: +90 372 252 1900; E-mail: drtanrikulu@hotmail.com

Inguinal hernia repair is one of the most common surgical procedures, and postoperative recovery is uncomplicated in most patients.[1] Early postoperative pain is risk factors a playing role in the development of chronic pain which is the most frequent complaint in long-term of inguinal hernia repair. Therefore, the prevention of early postoperative pain is very important. Risk factors for early postoperative pain include surgery for a recurrent hernia, insurance status of the patient, the degree of specialization and experience of the surgeon, the type of surgical procedure, and day surgery.[2–6]

There are various surgical and treatment methods to reduce of the severity of early postoperative pain. While the surgical treatment methods include type of surgery, use of lightweight meshes, nonstaple treatments, and a laparoscopic approach, medical treatment methods include the use of opioids and analgesics, regional nerve block, and postincisional local anesthetic administration. Although the purpose of modifications to the surgical procedure is to reduce the process of inflammation in the surgical field, the effect remains unclear.[7–10]

After surgical trauma, the degree of the inflammatory response is directly proportional to the size of the trauma.[11] Although there are a number of studies on the pain related with different surgical procedures, there isn't a study related with the peritoneal incision that increases the inflammatory response caused by the associated trauma of this process. The aim of this study was to evaluate the effect of peritoneal incision on immediate pain after inguinal hernia repair.

Materials and Methods

Study groups and design

This prospective study was conducted from February 1 to December 30, 2014, in the general surgery departments of an urban hospital, after being approved by the regional ethics review committee (Abant Izzet Baysal University Clinical Research Ethics Committee approval on 10/02/2014; approval no. 2013/43-31), and design and content of this study are fully compliant with criteria established by the STROBE (strengthening the reporting of observational studies in epidemiology) initiative.

The study enrolled 75 patients who were to undergo an operation for an inguinal hernia. Informed consent was obtained from all patients. The number of patients in the groups was calculated using a power analysis and were distributed evenly. The sample size was determined to be 15 patients per group with a power of 0.9 and 95% confidence interval. Patients were divided into 5 groups as follows:

1. ***Group 1***: Patients had an indirect hernia. The hernia sac was excised by cutting the peritoneum and a Lichtenstein repair with mesh was performed.
2. ***Group 2***: Patients had an indirect hernia. The hernia sac was embedded in the abdomen without a peritoneal incision. Plication sutures were placed on the defect and a Lichtenstein repair with mesh was performed.
3. ***Group 3***: Transabdominal preperitoneal (TAPP) hernia repair was performed in all patients regardless of the type of hernia.
4. ***Group 4***: Total extra peritoneal (TEP) hernia repair was performed in all patients regardless of the type of hernia.
5. ***Group 5***: Patients had a direct hernia. The hernia sac was embedded in the abdomen without a peritoneal incision. Plication sutures were placed on the defect and a Lichtenstein repair with mesh was performed.

With the exception of group 5, all patients scheduled for elective surgery were consecutively distributed equally in the groups. When a sufficient number of patients was reached, a related group stopped recruiting patients. In groups 1 and 2, patients who had only a direct hernia during surgery were instead included in group 5. Patients were excluded if any of the following criteria were present: younger than 16 years (no upper age limit); pregnant females; malignancies; emergency surgeries for incarcerated and/or strangulated hernia; recurrent hernia; urological pathology (e.g., varicocele, hydrocele) in the hernia region; or hernia induced by trauma. In addition, patients in groups 2, 4, and 5 in whom the peritoneum was accidentally cut were excluded.

Surgical procedures

Laparoscopic operations (TAPP and TEP) were performed under general anesthesia while Lichtenstein repairs were performed under spinal anesthesia. Paracetamol (1 g) was administered intravenously to each patient 30 minutes before the end of the operation. Single-dose antibiotic prophylaxis (1 g ampicillin sodium) was also administered to each patient. To ensure the standardization of the surgical procedure; all the procedures were performed by the same surgeon; a standard light-weight polypropylene mesh was used in all the surgical procedures. After obtaining initial pain scores, an additional dose of

Table 1 Characteristics of groups and early postoperative complications

Characteristics	n
Anesthesia, general/spinal	30/45
Sex, male/female	62/13
Mean age, y	51.25 ± 15.90
Surgical procedure, open/laparoscopic	45/30
Hernia side, right/left	39/36
Postoperative complications	
Urinary retention, n (%)	5 (6.7)
Wound infection, n (%)	1 (1.3)
Hematoma and/or seroma, n (%)	7 (9.3)
Bleeding, n (%)	1 (1.3)
Numbness, n (%)	4 (5.3)

paracetamol (1 g) was administered intravenously to each patient for postoperative analgesia. The mesh fixation was made with prolene sutures in open surgical procedures versus nonabsorbable staples in laparoscopic surgical procedures.

Pain VAS score

The VAS is a simple scale with a length of 100 mm on which patients were asked to rate their pain from 0 (absence of pain) to 100 (worst pain imaginable) (12). All patients were asked to mark their current sensation of pain on a VAS at 6 hours postoperatively, at the end of postoperative day 1, and on postoperative day 10. To minimize the possibility of bias, VAS measurements were performed by a single person independent from the surgical team.

Statistical analysis

Statistical analyses were performed with statistical software (SPSS 19.0, SPSS Inc, Chicago, Illinois). Distribution of data was determined by Shapiro-Wilk test. Variables were expressed as median (minimum-maximum). Continuous variables were compared with the Mann-Whitney *U* test for 2 groups. Kruskal-Wallis test was used to determine differences between 3 or more groups. The Dunn's test was used for post hoc analysis after the Kruskal-Wallis test. The repeated measures for analysis of variance or Friedman test was used to compare repeated measurements of the variables. Values of $P < 0.05$ were considered statistically significant for all tests.

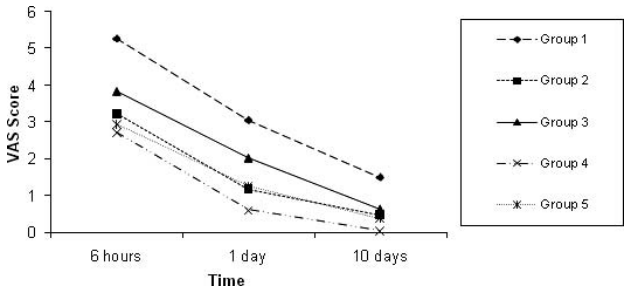

Fig. 1 VAS changes among groups and in each group.

Results

We evaluated 75 patients with inguinal hernias. There were 62 (82.7%) males and 13 (17.3%) females with a mean age of 51.25 ± 15.90 years. There was no difference in sex or mean age between the groups. Postoperative complications are summarized in Table 1. There were no serious complications and there was no difference between groups according to the nonserious complication. In addition, surgical operation was not necessary for any complications.

The analyses of VAS changes among the groups and in each group are summarized in Table 2 and Fig. 1. According to the VAS scores assessed at 6

Table 2 Analysis of the VAS variability between groups and in each group

	Group 1	Group 2	Group 3	Group 4	Group 5	Overall	P^{1a}
VAS 6h	5 (1–8.2)	2.8 (1–7.5)	3.8 (1.3–7)	2 (0.4–8)	2.5 (0.5–6.5)[b]	3 (0.4–8.2)	**0.007**
VAS 1d	2.1 (0.3–6.5)	0.8 (0–4.0)	0 (0–2)	1 (0–1.5)	0.8 (0–3.5)[f]	1 (0–6.5)	**<0.001**
VAS 10d	3.8 (1.3–7)	2 (0.5–4.5)	0.5 (0–1.5)	0 (0–0.5)	0.2 (0–1.5)	0.5 (0–4.7)	**<0.001**
P^{2b}	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**		

VAS 1d: postoperative day 1; VAS 6h: 6 hours postoperatively; VAS 10d, postoperative day 10.

[a]VAS analysis according to the groups is shown by P^1, and differences between the groups are as follows: VAS 6h: groups 4 and 5 versus group 1, $P = 0.006$ and 0.048, respectively; VAS 1d: group 4 versus group 3, $P = 0.008$; groups 2, 4, and 5 versus group 1, $P = 0.019$, $P < 0.001$, and $P = 0.033$, respectively; group 4 versus group 3, $P = 0.006$; groups 2, 4, and 5 versus group 1, $P < 0.001$, $P = 0.022$, and $P = 0.027$, respectively.

[b]VAS mobility in each group is shown by P^2, and differences between the groups are indicated as follows: group 1: VAS 10d versus VAS 6h, $P < 0.001$; group 2: VAS 1d and VAS 10d versus VAS 6h, $P = 0.004$ and $P < 0.001$, respectively; group 3: VAS 1d and VAS 10d versus VAS 6h, $P = 0.003$ and $P < 0.001$, respectively; group 3: VAS 1d versus VAS 10d, $P < 0.001$; group 4: VAS 1d and VAS 10d versus VAS 6h, $P = 0.008$ and $P < 0.001$, respectively; group 5: VAS 1d and VAS 10d versus VAS 6h, $P = 0.008$ and $P < 0.001$, respectively.

Table 3 The analysis of the VAS variability between open and laparoscopic surgery groups and in each group

	Open surgery	Laparoscopic surgery	Overall	P^{1a}
VAS 6h	4 (0.5–8.2)**	2.75 (0.4–8)**	3 (0.4–8.2)	0.279
VAS 1d	1.5 (0–6.5)	1 (0–4.5)	1 (0–6.5)	0.424
VAS 10d	0.5 (0–4.7)*	0.5 (0–4.7)*	0.5 (0–4.7)	0.051
P^{2b}	**<0.001**	**0.006**		

[a]VAS analysis according to the groups is shown by P^1.

[b]VAS mobility in each group is shown by P^2, and differences between the groups are indicated by symbols. **VAS 1d and VAS 10d versus VAS 6h, $P < 0.001$. *VAS 10d versus VAS 6h, $P = 0.006$.

hours postoperatively between groups, the median VAS score was lowest in group 4 and highest in group 1. VAS scores were significantly lower in groups 4 and 5 versus group 1 ($P = 0.006$ and 0.048, respectively). According to the VAS scores assessed on postoperative day 1, the median VAS score was lowest in group 3 and highest in group 1. VAS scores were significantly lower in groups 2, 4, and 5 versus group 1 ($P = 0.019$, $P < 0.001$, $P < 0.033$, respectively). VAS scores were significantly lower in group 4 than group 3 ($P = 0.008$). According to the VAS scores assessed on postoperative day 10, the median VAS score was lowest in group 4 and highest in group 1. VAS scores were significantly lower in groups 2, 4, and 5 versus group 1 ($P = 0.027$, $P < 0.001$, and $P < 0.022$, respectively). VAS scores were significantly lower in group 4 versus group 3 ($P = 0.006$). According to the VAS scores of the 5 groups, there were statistically significant differences among the 3 VAS scores at different time points ($P < 0.001$). VAS scores in groups 3, 4, and 5 declined gradually over time.

Analyses of differences in VAS between open and laparoscopic surgery groups and in each group are summarized in Table 3 and Fig. 2. At 6 hours, 1 day, and 10 days postoperatively, the differences were not statistically significant ($P = 0.279$, $P = 0.424$, and

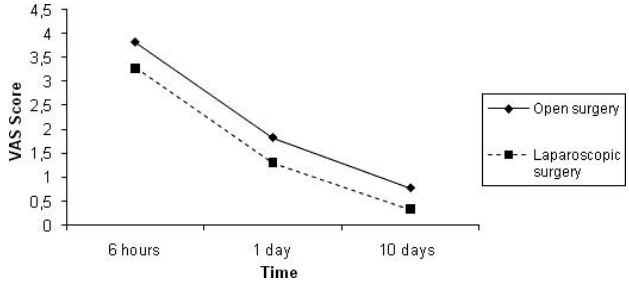

Fig. 2 VAS differences between open and laparoscopic surgery groups.

Table 4 The analysis of the VAS variability between hernia sides

	Right	Left	Overall	P^{1a}
VAS 6h	4.2 (0.5–8)**	2.5 (0.4–8.2)**	3 (0.4–8.2)	**0.035**
VAS 1d	1 (0–6.5)	1 (0–5)	1 (0–6.5)	0.491
VAS 10d	0.5 (0–4.7)*	0 (0–2.1)*	0.5 (0–4.7)	0.176
P^{2b}	**<0.001**	**<0.001**		

[a]VAS analysis according to the groups is shown by P^1.

[b]VAS mobility in each group is shown by P^2, and differences between the groups are indicated by symbols. **VAS 6h versus VAS 1[d] and VAS 10[d], $P < 0.001$. *VAS 6h versus VAS 10d, $P < 0.001$.

$P = 0.051$, respectively), although VAS scores were lower in the laparoscopic surgery group than the open surgery group. According to the VAS changes in the open and laparoscopic surgery groups, VAS scores decreased gradually in both groups; there was a statistically significant difference between the 3 time points ($P < 0.001$ for open surgery group, $P = 0.006$ for laparoscopic surgery group).

Analyses of VAS changes between hernia sides and in each group are summarized in Table 4 and Fig. 3. At 6 hours postoperatively, VAS scores were significantly lower in left-sided hernias than right-sided hernias ($P = 0.035$). At postoperative days 1 and 10, VAS scores were lower in left- versus right-sided hernias; however, the differences were not statistically significant ($P = 0.491$ for day 1, $P = 0.176$ for day 10). According to the VAS changes in the left- and right-sided hernia groups, VAS scores declined gradually in both groups, and there were statistically significant differences among the 3 time points ($P < 0.001$ for all).

Discussion

The severity of early postoperative pain plays an important role in the development of chronic pain. The pathophysiologic mechanisms of early postoperative pain include perioperative nerve damage, sensitization of nociceptors, early postoperative

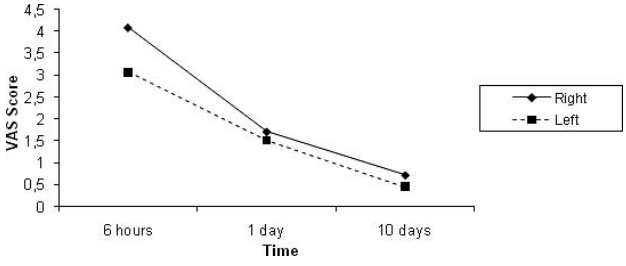

Fig. 3 VAS differences between hernia sides.

ectopic activity of injured primary afferents, and central sensitization.[11] This trial was a prospective clinical study on the effects of peritoneal incision on immediate pain after inguinal hernia repair.

Several preoperative (young age, female sex, genetic predisposition); perioperative (less experience, open repair procedure, nerve neurolysis); and postoperative risk factors (High early postoperative pain intensity, postoperative complications for the development chronic pain have been identified.[11] These factors can vary from patient to patient. Preoperative risk factors are closely associated with the individual patient and cannot be changed. However, various perioperative and postoperative risk factors can be avoided.

The first factor associated with postoperative pain is the use of mesh. Mesh repair is considered to be more effective in reducing recurrence and postoperative pain, in comparison with no-mesh repair. In addition, the structure of the mesh is an important factor in the development of postoperative pain, and use of a synthetic nonabsorbable flat mesh or composite mesh is recommended because these cause less pain.[11] Post *et al*[13] reported that the pain might be caused by the weight and composition of the mesh, and that the sensation of a foreign body was higher in the heavyweight mesh group. In contrast, Bringman *et al*[14] found no difference in postoperative pain between lightweight and heavyweight mesh groups. Another factor associated with mesh is fixation method. The use of staples to fix the mesh reduced both the operation time and time to return to normal activity, but did not affect the rates of complications or postoperative pain.[15] However, in one meta-analysis, glue fixation of the mesh was shown to reduce both postoperative pain and time to return to normal activity.[16]

The second issue associated with postoperative pain is identification and protection of the inguinal nerves. The identification of neuronal anatomy and the protection of nerves in the surgical region are important in reducing the risk of postoperative pain. However, practically, identification of all 3 nerves including the ilioinguinal, iliohypogastric, and genitofemoral nerves is quite poor. In one study, Ravindran *et al*[17] found that the ilioinguinal nerve was routinely identified by 88% of surgeons, the iliohypogastric nerve by 58%, and the genitofemoral nerve by 54%. A prospective multicenter study showed that the overall pain rate was 5.5% when all 3 nerves were identified.[18] We usually protect all nerves seen during open surgery. When accidentally severed, we ligate the nerve ends to reduce postoperative pain. Additionally, we strive not to put staples on nervous tracings during laparoscopic surgery.

The third factor associated with postoperative pain is the form of hernia surgery. Compared with open surgery, laparoscopic surgery may result in less postoperative pain. Additionally, other important advantages of the laparoscopic method are the short time to return to normal activity, good cosmetic results, and lower recurrence rates. The low pain rates in laparoscopic procedures are due to the shape of the mesh fixation and avoiding neuropathic complications without increasing the recurrence rate through fixation of abdominal pressure. Disadvantages of laparoscopic methods are the use of general anesthesia and longer duration of surgery.[19,20] Erhan *et al*[8] found no difference in postoperative pain between Lichtenstein and preperitoneal hernia repair groups. In contrast, Liem *et al*[21] showed that postoperative pain was reduced in a laparoscopic group than with conventional anterior surgery. In our study, although VAS scores were higher in the open surgery group than the laparoscopic surgery group, there was no statistically significant difference at any time point.

The final factor associated with postoperative pain is the process of inflammation in the surgical field, and this is main topic related to this study. Nociceptors located in primary afferent nerve endings are neurological receptors sensitive to stimuli caused by tissue damage. These receptors are found in the skin, periosteum, joints, muscles, visceral tissues, and peritoneum.[22–24] Postoperatively, inguinal nerves can become damaged due to enclosure within a meshoma, excessive fibrotic reaction, or inflammatory processes.[11] After trauma to the peritoneum, vascular permeability in vessels supplying the damaged region increases, inflammatory cells are released and, ultimately, there is formation of a fibrin matrix and an inflammatory response occurs.[25] This inflammatory response to surgery may lead to activation of peripheral nociceptors, causing postoperative pain.[11] Thus, as long as surgical trauma increases, postoperative pain will increase. In a study conducted by Muzio *et al*[26] found that there was no effect on the outcome and late postoperative pain of peritoneal tears in TEP inguinal hernia repair. In our study, at 6 hours postoperatively, VAS scores were significantly lower in group 5 than in group 1 ($P = 0.048$), but there was no difference between groups 2 and 5. VAS scores were significantly lower in group 4 than group 3 (P

$= 0.006$). At postoperative days 1 and 10, VAS scores were significantly lower in groups 2 and 5 versus group 1 ($P = 0.019$ and 0.033, respectively, for day 1; $P = 0.027$ and 0.022, respectively, for day 10), while there was no difference between groups 2 and 5. VAS scores were significantly lower in group 4 than in group 3 ($P = 0.006$) at day 10 while they were significantly higher in group 4 than in group 3 ($P = 0.008$) at day 1.

In conclusion, postoperative pain is an inevitable result of hernia surgery. There are many risk factors for postoperative pain. Each patient should be assessed individually and patient-specific surgical procedures must be selected because these factors vary among individual patients. Prevention of postoperative pain is important in terms of early discharge, early return to normal activity, cost effectiveness, and reducing the development of chronic pain. In this study, we found that a peritoneal incision is a significant risk factor for postoperative pain, but a laparoscopic approach is not. The most important limitations of this study are the small number of patients, limited follow-up, and because operation time was not measured, its effect on pain was not given. An investigation of the effects of peritoneal incision on chronic pain development with extended follow-up is warranted.

Acknowledgments

The authors declare no conflict of interest.

References

1. Kumar S, Wilson RG, Nixon SJ, Macintyre IM. Chronic pain after laparoscopic and open mesh repair of groin hernia. *Br J Surg* 2002;**89**(11):1476–1479
2. Ferzli GS, Edwards ED, Khoury GE. Chronic pain after inguinal herniorrhaphy. *J Am Coll Surg* 2007;**205**(2):333–341
3. Poobalan AS, Bruce J, Smith WC, King PM, Krukowski ZH, Chambers WA. A review of chronic pain after inguinal herniorrhaphy. *Clin J Pain* 2003;**19**(1):48–54
4. Bay-Nielsen M, Perkins FM, Kehlet H. Danish Hernia Database. Pain and functional impairment 1 year after inguinal herniorrhaphy: a nationwide questionnaire study. *Ann Surg* 2001;**233**(1):1–7
5. Callesen T, Bech K, Kehlet H. Prospective study of chronic pain after groin hernia repair. *Br J Surg* 1999;**86**(12):1528–1531
6. Salcedo-Wasicek MC, Thirlby RC. Postoperative course after inguinal herniorrhaphy. A case-controlled comparison of patients receiving workers' compensation vs patients with commercial insurance. *Arch Surg* 1995;**130**(1):29–32
7. Dennis R, O'Riordan D. Risk factors for chronic pain after inguinal hernia repair. *Ann R Coll Surg Engl* 2007;**89**(3):218–220
8. Erhan Y, Erhan E, Aydede H, Mercan M, Tok D. Chronic pain after Lichtenstein and preperitoneal (posterior) hernia repair. *Can J Surg* 2008;**51**(5):383–387
9. Köninger J, Redecke J, Butters M. Chronic pain after hernia repair: a randomized trial comparing Shouldice, Lichtenstein and TAPP. *Langenbecks Arch Surg* 2004;**389**(5):361–365
10. Santos Gde C, Braga GM, Queiroz FL, Navarro TP, Gomez RS. Assessment of postoperative pain and hospital discharge after inguinal and iliohypogastric nerve block for inguinal hernia repair under spinal anesthesia: a prospective study. *Rev Assoc Med Bras* 2011;**57**(5):545–549
11. Bjurstrom MF, Nicol AL, Amid PK, Chen DC. Pain control following inguinal herniorrhaphy: current perspectives. *J Pain Res* 2014;**7**:277–290
12. McCarthy M Jr, Chang CH, Pickard AS, Giobbie-Hurder A, Price DD, Jonasson O. Visual analog scales for assessing surgical pain. *J Am Coll Surg* 2005;**201**(2):245–252
13. Post S, Weiss B, Willer M, Neufang T, Lorenz D. Randomized clinical trial of lightweight composite mesh for Lichtenstein inguinal hernia repair. *Br J Surg* 2004;**91**(1):44–48
14. Bringman S, Wollert S, Osterberg J, Smedberg S, Granlund H, Heikkinen TJ. Three-year results of a randomized clinical trial of lightweight or Standard polypropylene mesh in Lichtenstein repair of primary inguinal hernia. *Br J Surg* 2006;**93**(9):1056–1059
15. Mills IW, McDermott IM, Ratliff DA. Prospective randomized controlled trial to compare skin staples and polypropylene for securing the mesh in inguinal hernia repair. *Br J Surg* 1998;**85**(6):790–792
16. Colvin HS, Rao A, Cavali M, Campanelli G, Amin AI. Glue versus suture fixation of mesh during open repair of inguinal hernias: a systematic review and meta-analysis. *World J Surg* 2013;**37**(10):2282–2292
17. Ravindran R, Bruce J, Debnath D, Poobalan A, King PM. A United Kingdom survey of surgical technique and handling practice of inguinal canal structures during hernia surgery. *Surgery* 2006;**139**(4):523–526
18. Hakeem A, Shanmugam V. Inguinodynia following Lichtenstein tension-free hernia repair: a review. *World J Gastroenterol* 2011;**17**(14):1791–1796
19. Nienhuijs S, Staal E, Keemers-Gels M, Rosman C, Strobbe L. Pain after open preperitoneal repair versus Lichtenstein repair: a randomized trial. *World J Surg* 2007;**31**(9):1751–1759
20. Hernandez-Rosa J, Lo CC, Choi JJ, Colon MJ, Boudourakis L, Telem DA. Laparoscopic versus open inguinal hernia repair in octogenarians. *Hernia* 2011;**15**(6):655–658
21. Liem MS, van der Graaf Y, van Steensel CJ, Boelhouwer RU, Clevers GJ, Meijer WS. Comparison of conventional anterior

surgery and laparoscopic surgery for inguinal-hernia repair. *N Engl J Med* 1997;**336**(22):1541–1547

22. Katz N, Ferrante FM. *Nociception*. USA, Churchill Livingstone, 1993
23. Heavner JE, Willis WD. Pain pathways: anatomy and physiology of pain. In: Raj PP, ed. *Practical Management of Pain*. 3rd ed. St. Louis, MO: The CV Mosby Co, 2000
24. Byers MR, Bonica JJ. Peripheral pain mechanisms and nociceptor plasticity. In: Loeser JD, Butler SH, Chapman CR, Turk DC, eds. Bonica's Management of Pain. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2001
25. Cheong YC, Laird SM, Li TC, Shelton JB, Ledger WL, Cooke ID. Peritoneal healing and adhesion formation/reformation. *Hum Reprod Update* 2001;**7**(6):556–566
26. Muzio G, Bernard K, Polliand C, Rizk N, Champault G. Impact of peritoneal tears on the outcome and late results (4 years) of endoscopic totally extra-peritoneal inguinal hernioplasty. *Hernia* 2006;**10**(5):426–429